

CHAPTER 4

2003 IN-PLANT FISH ASSESSMENT

INTRODUCTION

This chapter reports on fish impingement at the San Onofre Nuclear Generating Station (SONGS) in compliance with National Pollutant Discharge Elimination System (NPDES) requirements. The term "impingement" refers to entrapped fish that are killed in the SONGS cooling system and are removed by traveling screens. This chapter summarizes in-plant fish collection data for the year 2003 at San Onofre Units 2 and 3. San Onofre Unit 1 was taken out of service in 1992 and did not operate in 2003. Since circulating water pumps were not in service in 2003, no fish impingement samples could be taken, nor are they required by the NPDES permit.

Also included in this chapter is a report on the operation and effectiveness of "Fish Chase" procedures carried out in 2003 as a means of increasing fish survival at SONGS. The "Fish Chase" is a procedure used at SONGS to remove as many fish as possible from the circulating water system before heat treatment procedures are begun to eliminate fouling organisms from colonizing within the system¹.

Fish enter Units 2 and 3 of the generating station via seawater intakes supplying cooling water to the station. Most of the fish are guided through the intake screenwell to the fish return system and are returned to the ocean alive. Those remaining are impinged on the traveling screens and are deposited in containers for disposal. Estimates of the total number and weight of fish impinged during normal plant operation, including heat treatment, and analysis of size (age) and sex structure of select impinged species are presented in this report for Units 2 and 3 at SONGS.

¹ Information in this report regarding the Fish Chase procedure also meets requirements of Condition B of the Coastal Development Permit for SONGS (permit no. 6-81-330-A, formerly 183-73 issued by the California Coastal Commission.

METHODS

The analytical approach for this section utilizes tabular summaries of the number of individuals and biomass of fish impinged during normal operations and heat treatments. The total annual normal operation catch is calculated by multiplying the number of fish sampled during quarterly 24-hour sample periods by the total amount of sea water pumped during the year divided by the amount of water sampled during the 24-hour samples. Fish collected during heat treatments are added to the annual total. In other words:

$$I_t = i (f_a / f_s) + h_a$$

Where:

- I_t = Estimated total impingement for the year.
- i = Impinged fish in sample(s) during year.
- f_a = Amount of sea water pumped during the year.
- f_s = Total amount of sea water pumped during sample periods.
- h_a = Impinged fish in heat treatments during year.

In 1999, a new NPDES permit was issued to the San Onofre Nuclear Generating Station that reduced the requirement for fish impingement monitoring from monthly sampling to quarterly sampling. This change went into effect in August 1999. For this reason, normal operation samples were taken during each of the four calendar quarters in 2003 (January-March; April-June; July-September; and October-December). Monthly impingement was estimated by assuming the quarterly normal operation samples were representative of each of the days in the sampled quarter. Heat treatment fish loss is then added to the months during which the heat treatments occurred.

Length-frequency distributions of select species impinged in 2003 are constructed using samples of a maximum of 125 individuals for each normal operation and heat treatment sample. Fish were measured to the nearest millimeter. Sex ratios are estimated based on sub-samples of a maximum of 50 individuals per sample.

HEAT TREATMENT SAMPLES

Heat treatments at San Onofre involve recirculating approximately two-thirds of the normal discharge flow back through the condenser to achieve a temperature of 105°F (41°C) in the screenwell to control biofouling. The intake conduit is heat treated in this manner on an as-required schedule based upon a biofouling growth model (LCMR 1977) and operational requirements of the plant. During the heat treatment process, fish residing in the screenwell die due to the elevated temperatures. The dead fish are removed by screens and collected by biologists who separate them by species. They are then counted, weighed, and sub-samples are measured and their sex determined.

FISH CHASE

A "fish chase" procedure has been developed at SONGS to reduce the impact on fish populations by minimizing the number of fish killed during heat treatments.

Many fish accumulate in the cooling water system between heat treatments, often residing in habitat provided by gate slots and other structures within the system. Without the "fish chase" procedure, all fish residing in the circulating water system at the time of the heat treatment likely would be killed.

The fish chase is a procedure unique to SONGS. It was developed to allow live fish to move out of the circulating water system before beginning the heat treatment. This is accomplished by slowly manipulating cross-over gates in the vicinity of the screenwell, where most of the fish reside. This operation re-circulates effluent water so that the water is slowly warmed. The gate manipulations also create eddy currents that will dislodge fish that have congregated in areas of low flow. The elevated temperatures and new flow patterns are intended to agitate fish enough that they will seek new habitat and will find their way into the fish return elevator for release back to the ocean. The fish chase is monitored by biologists to assure that the fish are not overly stressed by the procedure. Engineers, operators and biologists are continuing to improve on the effectiveness of the fish chase by experimenting with various combinations of temperature and gate changes.

NORMAL OPERATION

Normal plant operation samples of fish are collected according to the frequency required by the station's NPDES permit, except during periods when the units are not in service due to refueling or maintenance. These 24-hour samples are intended to be representative of the amount of fish that enter the plant during a "normal" day's operation. In 2003, samples were taken quarterly throughout the year at both Units 2 and 3.

FISH RETURN SYSTEM

At Units 2 and 3, fish are guided via vanes and louvers to the fish return chamber where an elevator raises them to the surface of the intake screenwell and releases them via a sluiceway back to the ocean. Previously reported studies (SCE, 1988; Love, *et al*, 1989) assessed the effectiveness and survivorship of the fish return system. In 1999, additional studies of the fish return system were conducted as part of a special study for the California Coastal Commission. No fish return samples were taken in 2003.

The fish return system is operated by equipment operators at least twice daily and operations are logged on daily status sheets (Form SO123-0-10) (M. J. Johnson, Personal Communications).

DATA ANALYSIS

Analysis of impingement catch involves (1) estimating the catch of all fish species occurring during the year, (2) describing the length-frequency distributions of commonly occurring species, and (3) describing sex ratios of commonly occurring species. All weight, count, length measurement and gender determination data are provided in the 2003 Annual Data Report. This chapter of the Analysis Report presents catch data for the 15 most common species and length and sex data for species believed to be of particular interest to resource managers, assuming sufficient data exists for meaningful analysis.

The calculation used to determine the annual impingement catch in weight and numbers of fish during normal operation and heat treatment was described earlier in this section.

Fish released during the fish chase procedures are counted by biologists as the fish are raised in the fish return elevator. Biomass is determined by applying the values measured for fish of the same species taken in the subsequent heat treatment samples. That is, fish returned via the fish return system are assumed, on average, to weigh the same as fish taken in the following heat treatment.

Size structure and sex ratios of select species are examined using length-frequency histograms and sex ratio tables developed from data gathered during impingement sampling.

RESULTS AND DISCUSSION

SUMMARY OF PLANT OPERATIONS

The monthly operational status of each unit in 2003 is summarized in Table 4-1. The table shows the number of gallons of seawater pumped per month. The amount of power produced at the station is not necessarily related to the volume of seawater pumped. This is because circulating water pumps may have to be operated even when the station is not producing power and the pumps operate at only one speed whereas the plant may not always be run at maximum capacity.

Table 4-1. Monthly Circulating Water Flow in 2003.

Month	Unit 1 10 ⁶ gallons	Unit 2 10 ⁶ gallons	Unit 3 10 ⁶ gallons
January	157.76	37,783.15	7,930.99
February	141.89	34,127.30	22,711.99
March	156.99	37,782.84	37,781.06
April	152.18	36,563.58	36,561.98
May	160.67	37,782.55	37,782.55
June	152.54	35,964.17	35,964.17
July	157.53	37,782.01	37,780.65
August	157.40	37,781.59	37,781.00
September	152.33	152.33	36,562.32
October	157.55	157.55	37,781.69
November	152.27	36,564.36	36,562.59
December	157.60	37,782.71	37,780.94
Total	1,856.70	370,224.13	402,981.93

ANNUAL IMPINGEMENT ESTIMATE

Unit 1

Fish impingement at Unit 1 is assumed to be zero since no circulating water pumps were operated in 2003. Flows resulting from operation of service water pumps are negligible (equivalent to about four days of operation for the entire year) and insufficient to create enough flow velocity to entrain or impinge fish.

Unit 2

The 2003 annual impingement estimate for Unit 2 is based on four quarterly normal operation impingement samples and nine heat treatment samples conducted during the year. Appendix A lists all normal operation and heat treatment samples collected at Unit 2 in 2003. Table 4-2 shows the estimated monthly abundance of the 15 most abundant fish species and all species combined in 2003. Table 4-3 presents the estimated monthly biomass of the top 15 fish species by weight in kilograms. Monthly abundance and biomass of all species occurring at SONGS Unit 2 in 2003 are presented in detail in Appendices B and C, respectively.

A total of 62 species of fish were counted and weighed at Unit 2 in 2003. When weighted by the total amount of seawater used by Unit 2 in 2003, the estimated fish impingement was 995,398 individuals weighing 5,644.13 kilograms. The top 15 species accounted for 99.7% of the total number and 98.3% of the total weight. Northern anchovy were the most common species contributing 88.8% of the total number of fish and 61% of the total weight. Queenfish were the next most abundant species, contributing 8.2% of the total number of fish and 19.3% of the biomass.

Unit 3

The 2003 annual impingement estimate for Unit 3 is based on four normal operation impingement samples and seven heat treatment samples conducted during the year. Table 4-4 shows the estimated monthly abundance of the 15 most abundant fish species and all species combined in 2003. Table 4-5 presents the estimated monthly biomass of the top 15 fish species by weight in kilograms. A list of all normal operation and fish return samples taken in 2003 are presented in Appendix A. Monthly abundance and biomass of all species occurring at SONGS Unit 3 in 2003 are presented in detail in Appendix D and E, respectively.

A total of 60 species of fish were counted and weighed at Unit 3 in 2002. When weighted by the total amount of seawater used by Unit 3 in 2003, the estimated fish impingement was 2,569,039 individuals weighing 16,278.85 kilograms. The top 15 species accounted for 99.9% of the total number and 99.5% of the total weight. Northern anchovies were the most numerous species contributing 88.8% of the total number of fish (60.8% of the total weight). Queenfish were second most abundant fish with 7.5% of the total number and 17.9% of the total biomass.

Table 4-2. Estimated Monthly Count of Fish Impinged at Unit 2 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% of Total
northern anchovy	1832	1484	2921	20641	21923	23033	386746	386545	9574	22232	3854	2790	883575	88.77%
queenfish	2385	1904	3539	570	1417	1007	12210	11438	700	1709	22297	22570	81747	8.21%
Pacific sardine	506	112	134	30	32	30	2110	2108	32	4387	1618	1643	12742	1.28%
Pacific pompano	4	0	57	0	4	0	2023	2015	285	24	7	0	4419	0.44%
jacksmelt	630	28	445	30	66	50	152	93	3	24	277	279	2077	0.21%
walleye surfperch	59	0	16	270	282	273	287	124	144	20	45	31	1551	0.16%
shiner perch	42	0	5	0	74	37	500	403	81	151	108	0	1401	0.14%
salema	31	0	2	0	4	11	41	0	254	558	72	31	1004	0.10%
jack mackerel	95	56	70	0	1	1	131	124	3	27	198	124	830	0.08%
bocaccio	0	0	0	240	248	240	30	0	4	0	0	0	762	0.08%
white croaker	20	0	18	0	24	14	246	155	156	50	44	0	727	0.07%
topsmelt	53	0	1	0	0	81	133	93	1	64	146	31	603	0.06%
yellowfin croaker	8	0	4	0	0	1	119	0	26	361	7	0	526	0.05%
cabezon	0	0	1	120	148	188	20	0	2	1	0	0	480	0.05%
California grunion	63	56	62	60	68	63	0	0	0	0	0	0	372	0.04%
Total of top 15 species	5,728	3,640	7,275	21,961	24,291	25,027	404,748	403,097	11,267	29,608	28,673	27,499	992,816	99.74%
Total of all 62 species	5967	3696	7420	22111	24550	25398	405287	403252	11457	29753	28951	27654	995398	100.00%

Table 4-3. Estimated Monthly Weight (Kgs) of Fish Impinged at Unit 2 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% of Total
northern anchovy	5.690	3.920	12.020	231.615	243.777	263.448	1281.590	1279.906	26.640	75.254	13.811	8.061	3445.733	61.05%
queenfish	24.111	15.682	43.861	10.801	32.631	23.074	345.742	323.929	21.556	48.846	102.368	97.347	1089.948	19.31%
Pacific sardine	23.120	3.360	4.300	0.600	0.650	0.590	49.707	49.597	1.560	52.771	39.913	40.923	267.092	4.73%
yellowfin croaker	1.350	0.000	0.620	0.000	0.000	0.220	33.550	0.000	8.000	99.060	1.280	0.000	144.080	2.55%
plainfin midshipman	44.644	40.324	44.813	0.000	1.580	0.000	0.030	0.000	0.000	0.000	0.000	0.000	131.392	2.33%
jacksmelt	46.610	4.200	15.610	0.600	3.190	1.670	6.790	5.890	0.184	1.372	7.991	7.751	101.858	1.80%
Pacific pompano	0.140	0.000	2.860	0.000	0.180	0.000	40.968	40.607	7.694	0.400	0.150	0.000	92.999	1.65%
salema	0.300	0.000	0.060	0.000	0.120	0.510	2.400	0.000	22.840	36.981	0.880	0.124	64.215	1.14%
sargo	0.370	0.000	0.830	0.000	0.000	0.870	47.620	0.000	5.820	6.700	0.160	0.000	62.370	1.11%
jack mackerel	4.240	2.520	3.420	0.000	0.070	0.030	8.430	8.059	0.132	2.346	8.520	3.720	41.488	0.74%
topsmelt	1.070	0.000	0.030	0.000	0.000	2.480	5.420	4.030	0.066	1.916	12.980	1.550	29.542	0.52%
walleye surfperch	2.340	0.000	0.750	2.100	2.320	2.136	6.030	2.480	3.570	0.893	1.560	0.620	24.798	0.44%
barred sand bass	1.110	0.000	4.230	0.000	2.260	1.740	3.450	0.000	0.960	7.440	3.490	0.000	24.680	0.44%
shovelnose guitarfish	0.000	0.000	6.200	0.000	0.000	0.000	4.950	0.000	4.200	0.000	0.000	0.000	15.350	0.27%
shiner perch	0.720	0.000	0.180	1.200	3.390	1.450	1.310	0.000	1.080	2.350	2.140	0.000	13.821	0.24%
Total of top 15 species	155.8	70.0	139.8	246.9	290.2	298.2	1838.0	1714.5	104.3	336.3	195.2	160.1	5549.4	98.32%
Total of all 62 species	161.300	72.247	149.298	250.006	297.195	311.658	1856.301	1722.557	113.445	343.502	205.472	161.150	5644.131	100.00%

Table 4-4. Estimated Monthly Count of Fish Impinged at Unit 3 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% of Total
northern anchovy	2571	7361	12245	36927	39695	39714	717275	719876	699117	961	4430	1344	2281516	88.81%
queenfish	5122	14667	24398	4704	5008	5632	19900	21826	20051	22848	22327	25396	191879	7.47%
Pacific sardine	1223	3504	5828	123	124	141	12275	12282	11900	992	1060	1145	50597	1.97%
Pacific pompano	0	0	0	2	2	4	7439	7448	7253	0	9	5	22163	0.86%
jacksmelt	156	447	744	674	157	144	31	32	46	992	1154	1095	5672	0.22%
white seaperch	0	0	0	1142	1203	1156	31	55	33	0	2	2	3624	0.14%
white croaker	20	56	93	327	350	369	93	449	191	0	7	71	2025	0.08%
walleye surfperch	0	0	0	436	434	475	93	200	154	0	3	82	1877	0.07%
shiner perch	0	0	0	543	586	574	0	60	23	0	21	29	1836	0.07%
bocaccio	0	0	0	540	558	549	0	12	2	0	0	0	1661	0.06%
sargo	0	0	0	0	0	81	0	648	128	0	5	2	864	0.03%
specklefin midshipman	20	56	93	90	93	94	124	128	122	0	3	0	822	0.03%
black perch	0	0	0	182	213	203	0	6	1	0	2	0	607	0.02%
jack mackerel	0	0	0	2	0	5	0	2	157	62	152	112	492	0.02%
deep body anchovy	33	93	155	0	0	0	0	0	0	31	76	100	488	0.02%
Total of top 15 species	9,143	26,184	43,556	45,692	48,423	49,141	757,261	763,024	739,179	25,886	29,251	29,383	2,566,124	99.89%
Total of all 60 species	9156	26221	43618	46024	48742	49585	757416	763552	739581	25979	29523	29640	2569039	100.00%

Table 4-5. Estimated Monthly Weight (Kgs) of Fish Impinged at Unit 3 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% of Total
northern anchovy	8.004	22.922	38.131	442.730	487.952	486.609	2817.955	2827.231	2741.363	3.410	20.950	4.790	9902.048	60.83%
queenfish	51.411	147.226	244.908	87.441	101.714	123.075	583.367	647.293	595.135	103.545	105.814	118.343	2909.272	17.87%
Pacific sardine	54.470	155.985	259.478	6.140	6.200	6.862	512.074	512.368	495.981	16.121	17.081	18.840	2061.599	12.66%
Pacific pompano	0.000	0.000	0.000	0.080	0.080	0.140	158.706	158.957	154.638	0.000	0.270	0.130	473.001	2.91%
sargo	0.000	0.000	0.000	0.000	0.000	23.050	0.000	203.380	34.800	0.000	0.970	0.020	262.220	1.61%
jacksmelt	8.720	24.972	41.541	38.320	9.760	7.492	1.860	1.910	2.510	29.451	39.701	33.521	239.759	1.47%
specklefin midshipman	0.130	0.373	0.620	9.000	9.301	9.953	21.078	21.918	20.768	0.000	0.330	0.000	93.472	0.57%
yellowfin croaker	0.000	0.000	0.000	0.620	0.000	9.800	0.000	34.700	33.100	0.000	11.300	0.000	89.520	0.55%
white croaker	1.041	2.982	4.960	6.050	7.120	7.056	0.930	9.630	2.980	0.000	0.380	1.660	44.790	0.28%
jack mackerel	0.000	0.000	0.000	0.080	0.000	0.220	0.000	0.210	10.760	0.620	9.450	3.440	24.780	0.15%
white seaperch	0.000	0.000	0.000	4.505	4.860	5.357	2.790	3.620	2.860	0.000	0.050	0.020	24.061	0.15%
walleye surfperch	0.000	0.000	0.000	3.750	3.100	4.141	1.860	4.440	3.600	0.000	0.070	2.310	23.271	0.14%
shovelnose guitarfish	0.000	0.000	0.000	2.280	0.000	5.000	0.000	5.000	4.060	0.000	0.000	0.000	16.340	0.10%
barred sand bass	0.000	0.000	0.000	2.150	1.850	2.060	0.000	3.160	1.930	0.000	4.600	0.000	15.750	0.10%
salema	0.000	0.000	0.000	0.100	0.100	1.140	0.000	7.440	3.270	0.000	0.470	0.640	13.160	0.08%
Total of top 15 species	123.8	354.5	589.6	603.2	632.0	692.0	4100.6	4441.3	4107.8	153.1	211.4	183.7	16193.0	99.47%
Total of all 60 species	124.239	355.783	591.839	616.427	642.888	705.825	4105.888	4453.116	4119.154	155.348	220.516	187.829	16278.853	100.00%

Heat Treatment Operations and "Fish Chase".

"Heat treatments" are conducted on an "as needed" basis at coastal generating stations to control the growth of fouling organisms such as mussels and barnacles. The timing of these operations is dependent on season, ocean temperature, and observed settlement and growth of fouling organisms. The operations typically occur about every six weeks. The water temperature within the station is elevated to a temperature that will be lethal to the fouling organisms within the plant. Since this temperature is also lethal to fish residing in the station, a special operation called a "fish chase" has been developed at San Onofre to cause fish to leave the station alive before the heat treatment begins. Table 4-6 summarizes the number and weight of fish returned to the ocean during the fish chase that occurs just prior to the heat treatment and the percent of those fish returned to the ocean compared to the number of fish killed during the heat treatment process at SONGS Units 2 and 3.

In 2003, a total of 1,818 kgs of fish were impinged during heat treatment operations at SONGS. At the same time, as a result of the "Fish Chase" procedure, 2,386 kgs of fish were successfully released back to the ocean prior to the heat treatments. The percentage of fish released varied among the heat treatments, but averaged 56.8% for the year. The percent of fish released during the fish chase varied from 32.3% to 69.9% of the total (i.e., fish chase divided by heat treatment plus fish chase) biomass. Fluctuations in the release percentage are believed to be a result of entrainment of fish during the heat treatment process, after the fish chase is completed. For example, fish species such as northern anchovies, which are very well guided by the fish return system and are usually the first fish to be released, may appear late in the heat treatment process. This indicates that they have entered the station after the heat treatment process began. A summary of Fish Chase operations is presented in Table 4-7.

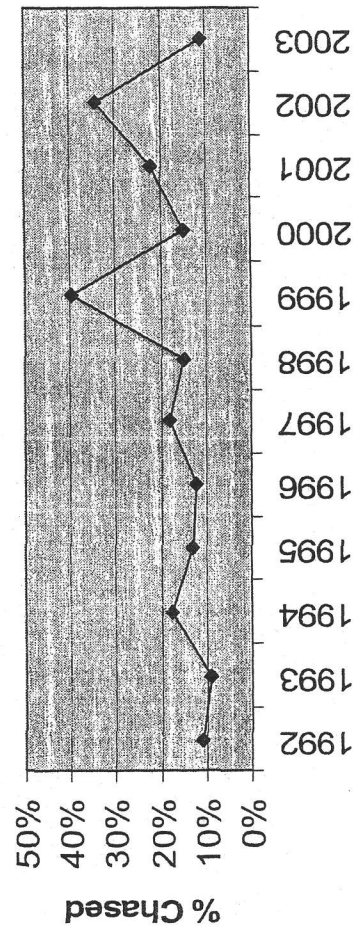
**Table 4-6. Fish Chase Efficiency by Heat Treatment
for Units 2 and 3 in 2003**

Unit	Date	Fish Chase Kilograms	Heat Treatment Kilograms	Percent Released
Unit 2	1/3/2003	108.01	81.32	57.0%
Unit 2	3/27/2003	88.00	69.30	55.9%
Unit 2	5/2/2003	31.90	38.86	45.1%
Unit 2	6/14/2003	26.68	65.75	28.9%
Unit 2	7/30/2003	94.12	133.72	41.3%
Unit 2	9/6/2003	100.93	51.51	66.2%
Unit 2	9/7/2003	30.54	55.01	35.7%
Unit 2	10/19/2003	200.76	342.81	36.9%
Unit 2	11/28/2003	36.57	49.52	42.5%
Unit 3	4/3/2003	124.64	75.97	62.1%
Unit 3	5/17/2003	118.43	84.39	58.4%
Unit 3	6/28/2003	183.61	174.19	51.3%
Unit 3	8/16/2003	805.08	347.20	69.9%
Unit 3	9/27/2003	337.41	145.66	69.8%
Unit 3	11/1/2003	84.22	70.17	54.6%
Unit 3	12/14/2003	15.52	32.48	32.3%
Totals		2,386	1,818	56.8%

Table 4-7. Description of Fish Chase Operations in 2003

				Elevator				Heat Treatment				
Unit	Date	Start Time	Intake Temp.	Max FC Temp.	Operational Status	# of Dumps	Condition of fish	No. of Fish	Fish Weight	No. of Fish	Fish Biomass	Comment
2	1/3/03	0410	59	82.1	Good	19	Good	1509	108.01	1775	81.32	No unusual events
2	3/27/03	0132	58	80.9	Good	15	Good	3842	88	3328	69.299	No unusual events
2	5/2/03	0800	59.5	83	Good	13	Good	2049	31.895	1701	38.856	Two sea lions rescued during heat treat
2	6/14/03	0812	64	83.5	Good	13	Good	1252	26.68	3649	65.747	No unusual events
2	7/30/03	2028	62	82.5	Good	20	Good	1225	94.12	2030	133.721	No unusual events
2	9/6/03	1548	62.5	85.3	H.T. curtailed	19	Good	1393	100.93	2671	51.513	H.T. Postponed
2	9/7/03	1530	63	85.5	Good	19	Good	1695	30.54	7160	55.012	No unusual events
2	10/19/03	1221	65	87	Good	20	Good	11845	200.76	29638	342.81	No unusual events
2	11/28/03	0937	60	80	Good	15	Good	823	36.57	2189	49.524	No unusual events
3	4/3/03	0832	58.5	83	Good	20	Good	1706	121.637	2193	75.974	Two giant seabass released prior to chase
3	5/17/03	2006	59.5	82.5	Good	18	Good	4290	118.43	3448	84.385	Giant seabass released during chase.
3	6/28/03	1932	62.9	83	Good	26	Good	1901	183.614	6471	174.186	Four giant seabass released.
3	8/16/03	2045	63.7	84.1	Good	20	Good	13199	805.08	6589	145.655	Dominated by yellowfin croaker
3	9/27/03	2000	67	83	Good	20	Good	24246	337.411	6589	145.655	Dominated by yellowfin croaker
3	11/1/03	1030	66	85	Good	24	Good	4657	84.22	4382	70.17	Sea Lion observed but avoided capture
3	12/14/03	0800	59	83.4	Good	17	Good	313	15.521	3661	32.481	No unusual events

Figure 4-1. Percent of Total Biomass Returned in Fish Chase



In Table 4-7 above, "Operational Status" provides information on the overall success of the fish chase procedure from an operational standpoint, i.e., whether it was completed as scheduled or not. "Condition of Fish" is a qualitative evaluation of how the fish appeared as they were released. A designation of "Good" means that less than 5% of the fish released appeared weakened or dead. The target temperature for a fish chase is usually 83°F. (28.3° C.) However, higher temperatures may be necessary to remove warm water species such as yellowfin croaker, sargo and zebra perch. In 2003, maximum temperatures ranged from 80° to 87° F.(24.2° to 30.0° C.). Graphs of temperature curves for each fish chase are presented in Appendix F. Table 4-8 presents a summary of fish released during the Fish Chase operations in 2003. The table provides the percent returned by numbers and biomass for the 15 most common species based on biomass. Appendix G provides the same information for all species taken at SONGS in 2003. Appendix H lists observations of species that may be of special interest to some researchers and resource managers.

Table 4-8. Summary of Fish Released During Fish Chase Operations in 2003 (Top 15 Species by Biomass)

Common Name	Unit 2 Fish Chase		Unit 3 Fish Chase		Unit 2 Heat treat		Unit 3 Heat treat		% Returned by Count	% Returned by Biomass
	Number	Kgs	Number	Kgs	Number	Kgs	Number	Kgs		
sargo	361	70.49	1056	314.65	326	62.37	864	262.22	54.35%	54.27%
northern anchovy	16703	80.07	44266	217.69	36377	153.48	16997	127.5	53.32%	51.45%
queenfish	2874	65.8	2264	56.66	6478	165.83	10418	245.21	23.32%	22.95%
spotfin croaker	27	10.71	673	430.59	8	0.27	8	3.73	97.77%	99.10%
yellowfin croaker	281	76.91	418	87.1	526	144.08	416	89.52	42.60%	41.25%
giant seabass	1	16	14	333					100.00%	100.00%
jacksmelt	1621	90.22	217	12.31	1160	59.46	1017	57.12	45.78%	46.79%
salema	963	62.48	776	45.75	943	63.97	266	13.16	58.99%	58.39%
barred sand bass	303	62.15	213	35.28	127	24.68	85	15.75	70.88%	70.67%
Pacific sardine	1366	28.77	54	1.43	4827	74.39	307	6.01	21.67%	27.31%
shovelnose guitarfish	10	48.21	1	8	3	15.35	5	16.34	57.89%	63.95%
bat ray	1	0.5	8	46.35			1	0.67	90.00%	98.59%
jack mackerel	125	9.76			157	9.9	308	22.94	21.19%	22.91%
walleye surfperch	337	12.71	74	3.28	427	12.27	334	8.7	35.07%	43.26%
white croaker	27	0.94	39	1.24	416	9.72	766	21.28	5.29%	6.57%
Totals for Top 15 species	25000	635.72	50073	1593.33	51775	795.77	31792	890.15	47.32%	56.94%
Totals for all 75 species	25633	717	50312	1669	54141	888	32873	930	46.60%	56.76%

Fish Return System Operation

The SONGS fish return system is normally operated twice per day by station operators. It is a routine part of station operations that is logged on daily status sheets (Form SO123-0-10) (M. J. Johnson, Personal Communication). A summary of exceptions to daily operability of the fish return system in 2003 is detailed in Table 4-8.

Eleven years of data were collected from 1984 through 1994 to characterize the return efficiency of the fish return system. In 1999, an additional special study was conducted of the system. A summary of data on the return efficiency of the fish return system during those years is presented in Table 4-9. Return efficiency is the percent of fish returned to the ocean alive during normal operation compared to the number of fish impinged and does not include fish returned during the "fish chase". No fish return samples were taken in 2003.

Table 4-9. Operating status of the Fish Return System in 2002.

Unit	Total Hours FRS Out of Service in 2002	Reason FRS was Out of Service	% System Availability in 2003
2	168	Maintenance	98
3	120	Maintenance	98

Table 4-10. Fish Return Efficiency 1984-1994 and 1999

Year	Unit 2 Percent Returned	Unit 3 Percent Returned
1984	96.50	95.40
1985	88.30	60.10
1986	75.00	69.90
1987	65.00	67.80
1988	80.00	68.50
1989	41.60	58.40
1990	51.50	36.60
1991	75.40	66.30
1992	74.40	59.30
1993	83.00	78.00
1994	87.70	78.40
1999	72.40	68.22

LENGTH FREQUENCY ANALYSIS

Figures 4-2 through 4-5 present length-frequency distributions of queenfish, northern anchovy, white croaker and Pacific sardine collected in-plant at Units 2 and 3 during 2003. These species were selected either because of their predominance in the catch (e.g., queenfish and northern anchovy) or because of their interest to resource managers (e.g., Pacific sardine and white croaker). Length data for all other species is provided in the 2003 data report.

Fig. 4-2. Queenfish Lengths

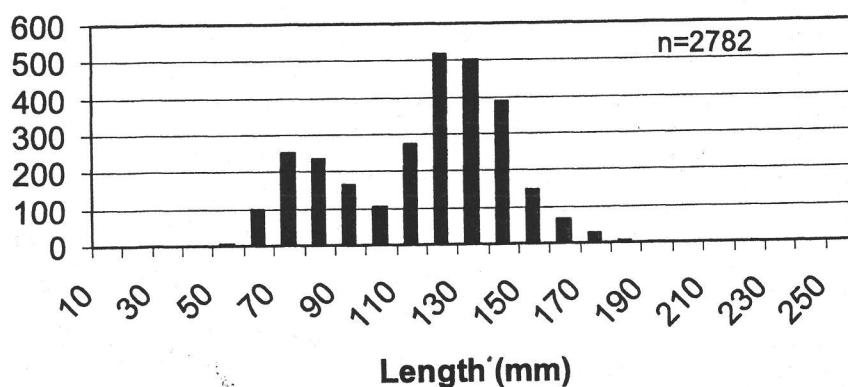


Fig. 4-3. Northern Anchovy Lengths

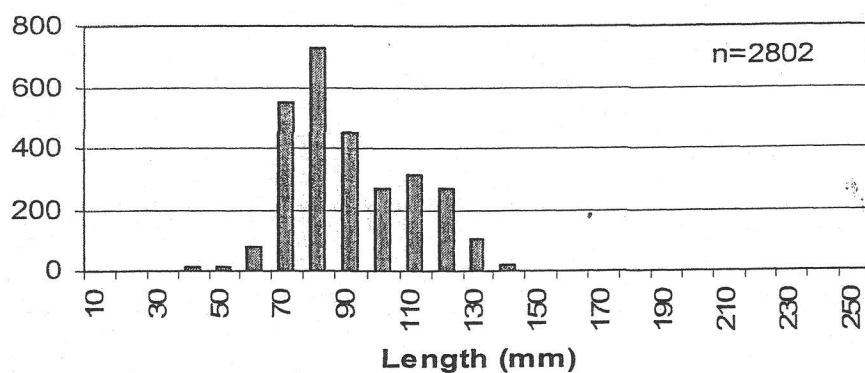


Fig. 4-4. White Croaker Lengths

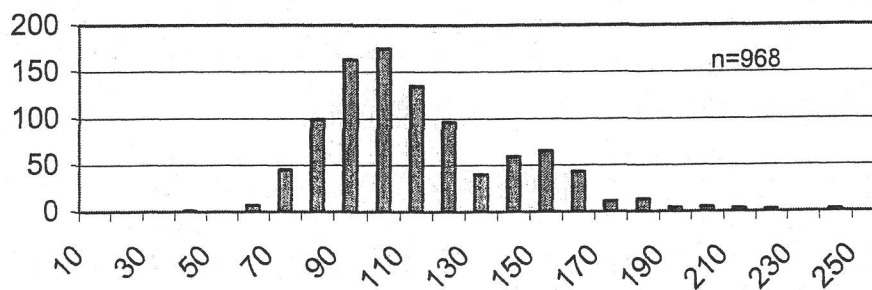
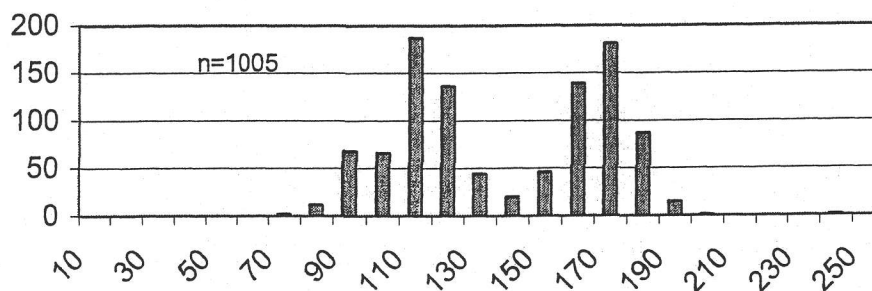


Fig. 4-5. Pacific Sardine Lengths



As in most years, northern anchovy and queenfish were numerous in 2003 and accounted for over 97% of the total catch at Unit 2, by number, and 96% at Unit 2.

The annual abundance of queenfish has fluctuated significantly from year to year with an apparent relationship with ENSO (El Niño/La Niña) events. Though abundance has remained generally strong during both warm and cool water periods, there were marked declines during the strong warm-water ENSO events of 1982-83, 1987 and 1997-98. In 1999 and 2000, cold water years, queenfish abundance was approximately double that of 1998. In 2001, following a return to more normal temperatures, queenfish abundance fell to the 1998 level but in 2002 nearly doubled in number from 2001. Numbers declined again in 2003. Queenfish lengths ranged from 30 to 180 mm. The length distribution was distinctly bimodal. The modes were at 70 and 120 mm (the same as in 2001 and 2002) representing mostly Age 0 and Age 1 individuals. Recruitment of young-of-the-year (YOY) appeared weak in 2003.

Northern anchovy were particularly abundant in 2003, accounting for over 88% of the catch at both units. Leet, et al. (1992) points out that northern anchovies rarely exceed four years in age and seven inches in length and there is a great deal of regional variation in age composition and size at age with older, larger, fish found at relatively offshore and northerly locations. At SONGS in 2003, northern anchovy lengths ranged mostly from 50 to 150 mm throughout the year, with length modes at 90 and 110 mm. The smaller size class (around 50 mm) correlates to an age of 1.5 to 2.5 months (Sakagawa and Kimura 1976). Interestingly, large numbers of northern anchovies have been occurring at SONGS in alternate years. They were numerous in 1999, 2001, and, now, 2003. Fewer were seen in 2000 and 2002. Though usually abundant, the northern anchovy biomass fluctuations may be a result of global changes such as El Niño/La Niña conditions or just the patchiness of their distribution along the coast.

Unlike queenfish, whose abundance has fluctuated from year to year but has not shown any long-term decline, white croaker abundance over the same period exhibited an overall downward trend, until 1999. In 1999, perhaps due to the colder water temperatures, white croaker abundances increased to nearly 10 times that of 1998. In 2000 the trend continued with numbers ten times greater than in 1999. In 2001 white croaker numbers declined dramatically in the impingement catch, but increased significantly in the trawl catch (see report for 2001 data, Chapter 5). This may indicate that white croaker populations were moving further offshore. In 2003, impingement catch was slightly higher than in 2001 and 2002. Recruitment also appears to have been weak in 2003, as it was in 2001 and 2002.

Pacific sardines, which increased in number slightly in 2002 when compared to 2000 and 2001, continued to increase at an even greater rate in 2003. As in previous years, numbers continued to be higher at Unit 3 than at Unit 2. In 2003, the sardines ranged from 70 to 200 mm. Unlike the age distribution in 2002 when the Age 0 year class was very weak, 2003 showed strong Age 0 as well as a strong Age 1 year classes. This suggests strong recruitment of sardines in 2003 and expectation of even larger numbers of sardines in 2004.

SEX COMPOSITION

Sex ratios of fish impinged at Units 2 and 3 are summarized in Table 4-11. As observed in past years, females frequently outnumbered males for many of the species studied. This is especially true of some of the perches, white croaker, and queenfish. This may be due to increased vulnerability to impingement of gravid females, especially the embiotocids that have impaired swimming ability. These characteristics are consistent with data from previous years.

Table 4-11. Count by Sex of fish captured at SONGS in 2003.

Common Name	Scientific Name	Gender		%
		Female	Male	
sargo	<i>Anisotremus davidsonii</i>	140	129	52.04%
kelp perch	<i>Brachyistius frenatus</i>	35	24	59.32%
black croaker	<i>Cheilotrema saturnum</i>	11	9	55.00%
shiner perch	<i>Cymatogaster aggregata</i>	380	180	67.86%
black perch	<i>Embiotoca jacksoni</i>	71	26	73.20%
northern anchovy	<i>Engraulis mordax</i>	339	205	62.32%
white croaker	<i>Genyonemus lineatus</i>	167	90	64.98%
rock wrasse	<i>Halichoeres semicinctus</i>	7	5	58.33%
horn shark	<i>Heterodontus francisci</i>	1	1	50.00%
walleye surfperch	<i>Hyperprosopon argenteum</i>	229	159	59.02%
California corbina	<i>Menticirrhus undulatus</i>	1	1	50.00%
gray smoothhound	<i>Mustelus californicus</i>	0	1	0.00%
bat ray	<i>Myliobatis californica</i>	0	1	0.00%
kelpbass	<i>Paralabrax clathratus</i>	6	3	66.67%
barred sand bass	<i>Paralabrax nebulifer</i>	52	33	61.18%
California halibut	<i>Paralichthys californicus</i>	1	0	100.00%
Pacific pompano	<i>Peprillus simillimus</i>	89	56	61.38%
white seaperch	<i>Phanerodon furcatus</i>	76	8	90.48%
rubberlip seaperch	<i>Rhacochilus toxotes</i>	2	1	66.67%
pile perch	<i>Rhacochilus vacca</i>	2	0	100.00%
shovelnose guitarfish	<i>Rhinobatos productus</i>	2	4	33.33%
spotfin croaker	<i>Roncador stearnsii</i>	4	3	57.14%
Pacific sardine	<i>Sardinops sagax</i>	109	138	44.13%
queenfish	<i>Seriphus politus</i>	496	379	56.69%
yellowfin croaker	<i>Umbrina roncadore</i>	116	227	33.82%
round stingray	<i>Urolophus halleri</i>	3	1	75.00%

TOTAL IMPINGEMENT

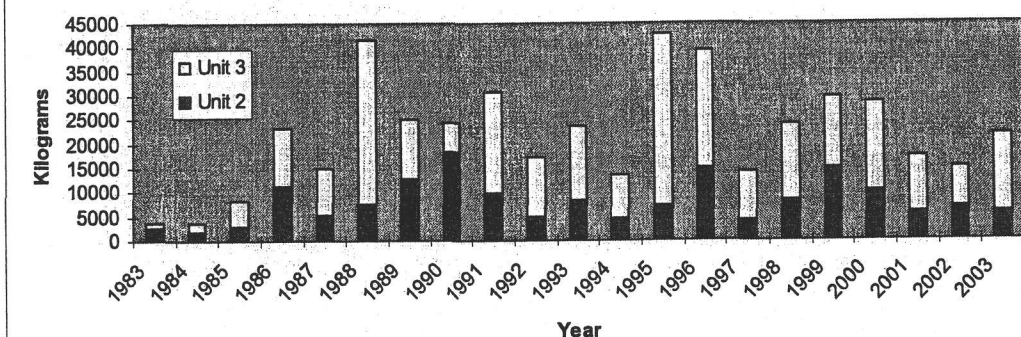
The total impingement fish loss for 2003 is the sum of the estimated annual impingement loss during normal operation plus fish impinged during heat treatment. Estimated annual impingement for Unit 2 in 2003, for all species combined, was 995,398 fish weighing 5,644 kilograms. Annual impingement at Unit 3 was 2,569,093 fish weighing 16,279 kilograms (Table 4-12). Most of the catch was composed of northern anchovies.

Table 4-12. Total number and weight of fish caught at San Onofre Units 2 & 3 in 2003

Unit	Normal Operation Impingement Total	Heat Treatment Total	Total Fish Impingement
2 (Count)	941,257	54,141	995,398
2 (Biomass)	4,756	888	5,644
3 (Count)	2,536,220	32,873	2,569,093
3 (Biomass)	15,349	930	16,279

Compared to previous years of operation, the total 2003 impinged biomass (21,932 kg) was very close to the 20-year average of 22,064 kg recorded since Units 2 and 3 began operation and well within the normal variation of samples in past years. Changes in impingement catch at SONGS are likely the result of large-scale climatological and oceanographic perturbations unrelated to operation of the generating station. The impingement data collected at SONGS is frequently used by resource managers as an indicator of natural fluctuations in near-shore fish populations.

Fig. 4-6. SONGS Impingement 1983-2003

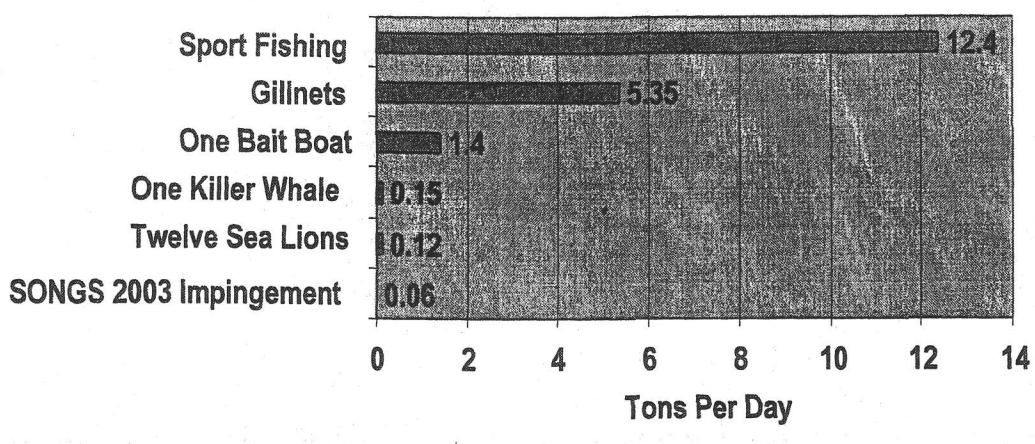


COMPARISON TO OTHER SOURCES OF FISH LOSS

This report provides an estimate of fish loss due to impingement resulting from the use of seawater as a source of cooling water for the San Onofre Nuclear Generating Station. In order to put these losses in perspective, it may be useful to compare the impingement losses with other losses routinely experienced by Southern California fish populations.

Figure 4-7 presents a variety of stresses on local fish populations and their relative magnitude in relation to SONGS impingement.

Figure 4-7. Comparison of Daily Losses.



Data source: ¹ 2003 Songs Annual Analysis Report; ²⁻³ "Marine Mammals of California" by A.E. Daugherty, 1979; ⁴ C. Cooney, Cal F&G, pers. com.; ⁵ Cal F&G/MMS computer data base; ⁶ U.S. Dept. of Commerce, Marine Rec. Fishery Statistics Survey, Pacific Coast 1981-1984 (within 3 miles of shore).

SUMMARY

IMPINGEMENT

Overall, the number and weight of fish impinged at San Onofre in 2003 was very near the 20-year average, and well within the range of values recorded since Units 2 and 3 began operation. There is no indication that fish impingement at SONGS has significantly impacted the maintenance of a balanced, indigenous fish population in the receiving water, nor did it impair any beneficial uses dependent on the fisheries resources.

Unit 1

Fish impingement at Unit 1 is assumed to be zero since no circulating water pumps were operated in 2003. Flows resulting from operation of service water pumps are negligible (equivalent to less than 5 days of operation for the entire year) and insufficient to create enough flow velocity to entrain or impinge fish.

Unit 2

A total of 62 species of fish were counted and weighed at Unit 2 in 2003. When weighted by the total amount of seawater used by Unit 2 in 2003, the estimated fish impingement was 995,398 individuals weighing 5,644 kilograms. The top 15 species accounted for 99.7% of the total number and 98.3% of the total weight. Northern anchovies were the most common species contributing 88.8% of the total number of fish and 61.0% of the total weight. Queenfish were the next most abundant species, contributing 8.21% of the total number of fish and 19.31% of the biomass.

Unit 3

A total of 60 species of fish were counted and weighed at Unit 3 in 2003. When weighted by the total amount of seawater used by Unit 3 in 2003, the estimated fish impingement was 2,569,039 individuals weighing 16,279 kilograms. The top 15 species accounted for 99.9% of the total number and 99.5% of the total weight. Northern anchovies were the most numerous species contributing 88.8% of the total number of fish and 60.8% of the total weight. Queenfish were second most abundant with 7.5% of the total by number and 17.9% of the total biomass.

FISH CHASE

A special procedure called a "fish chase" has been developed at San Onofre to cause fish to leave the circulating water system before heat treatments begin. In 2003, a total of 1,818 kgs of fish were impinged during heat treatment operations at SONGS. At the same time, as a result of the "Fish Chase" procedure, 2,386 kgs of fish were successfully released back to the ocean prior to the heat treatments. The percentage of fish released varied among the heat treatments, but averaged 56.8%, by biomass, for the year.

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APPENDIX A

List of Normal Operation and Fish Return Samples at SONGS Units 2 & 3 in 2003.

Appendix A. Heat Treatment and Normal Operation Samples Taken at Units 2&3 During 2003.				
Unit	Sample Type	Date	Number of Fish	Fish Biomass (Kgs.)
San Onofre 2	Fish Chase	1/3/2003	1509	108.01
San Onofre 2	Heat Treatment	1/3/2003	1775	81.318
San Onofre 2	Normal Operation	2/25/2003	132	2.579
San Onofre 2	Fish Chase	3/27/2003	3842	88
San Onofre 2	Heat Treatment	3/27/2003	3328	69.299
San Onofre 2	Fish Chase	5/2/2003	2049	31.895
San Onofre 2	Heat Treatment	5/2/2003	1701	38.856
San Onofre 2	Normal Operation	6/3/2003	750	8.336
San Onofre 2	Fish Chase	6/14/2003	1252	26.68
San Onofre 2	Heat Treatment	6/14/2003	3649	65.747
San Onofre 2	Fish Chase	7/30/2003	1225	94.12
San Onofre 2	Heat Treatment	7/30/2003	2030	133.721
San Onofre 2	Normal Operation	9/2/2003	12996	55.551
San Onofre 2	Fish Chase	9/6/2003	1393	100.93
San Onofre 2	Heat Treatment	9/6/2003	2671	51.513
San Onofre 2	Fish Chase	9/7/2003	1695	30.54
San Onofre 2	Heat Treatment	9/7/2003	7160	55.012
San Onofre 2	Fish Chase	10/19/2003	11845	200.756
San Onofre 2	Heat Treatment	10/19/2003	29638	342.81
San Onofre 2	Fish Chase	11/28/2003	823	36.569
San Onofre 2	Heat Treatment	11/28/2003	2189	49.524
San Onofre 2	Normal Operation	12/9/2003	892	5.207
San Onofre 3	Normal Operation	2/25/2003	1407	19.093
San Onofre 3	Fish Chase	4/3/2003	1706	124.637
San Onofre 3	Heat Treatment	4/3/2003	2193	75.974
San Onofre 3	Fish Chase	5/17/2003	4290	118.43
San Onofre 3	Heat Treatment	5/17/2003	3448	84.385
San Onofre 3	Normal Operation	6/3/2003	1461	18.006
San Onofre 3	Fish Chase	6/28/2003	1901	183.614
San Onofre 3	Heat Treatment	6/28/2003	6471	174.186
San Onofre 3	Fish Chase	8/16/2003	13199	805.08
San Onofre 3	Heat Treatment	8/16/2003	6129	347.202
San Onofre 3	Normal Operation	9/2/2003	24435	132.447
San Onofre 3	Fish Chase	9/27/2003	24246	337.411
San Onofre 3	Heat Treatment	9/27/2003	6589	145.655
San Onofre 3	Fish Chase	11/1/2003	4657	84.22
San Onofre 3	Heat Treatment	11/1/2003	4382	70.17
San Onofre 3	Normal Operation	12/9/2003	838	5.007
San Onofre 3	Fish Chase	12/14/2003	313	15.521
San Onofre 3	Heat Treatment	12/14/2003	3661	32.481

APPENDIX B.

**Estimated Monthly Number of Fish Impinged
at SONGS Unit 2 in 2003.**

Appendix B. Estimated Monthly Number of Fish at SONGS Unit 2 in 2003

Unit 2 Count Common Name	Extrapolated Catch Per Day By Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
northern anchovy	1832	1484	2921	20641	21923	23033	386746	386545	9574	22232	3854	2790	883575
queenfish	2385	1904	3539	570	1417	1007	12210	11438	700	1709	22297	22570	81747
Pacific sardine	506	112	134	30	32	30	2110	2108	32	4387	1618	1643	12742
Pacific pompano	4	0	57	0	4	0	2023	2015	285	24	7	0	4419
jacksmelt	630	28	445	30	66	50	152	93	3	24	277	279	2077
walleye surfperch	59	0	16	270	282	273	287	124	144	20	45	31	1551
shiner perch	42	0	5	0	74	37	500	403	81	151	108	0	1401
salema	31	0	2	0	4	11	41	0	254	558	72	31	1004
jack mackerel	95	56	70	0	1	1	131	124	3	27	198	124	830
bocaccio	0	0	0	240	248	240	30	0	4	0	0	0	762
white croaker	20	0	18	0	24	14	246	155	156	50	44	0	727
topsmelt	53	0	1	0	0	81	133	93	1	64	146	31	603
yellowfin croaker	8	0	4	0	0	1	119	0	26	361	7	0	526
cabezon	0	0	1	120	148	188	20	0	2	1	0	0	480
California grunion	63	56	62	60	68	63	0	0	0	0	0	0	372
white seaperch	6	0	6	90	95	105	27	0	34	9	0	0	372
sargo	2	0	2	0	0	8	241	0	26	42	5	0	326
giant kelpfish	39	28	33	0	3	3	44	31	6	3	36	31	257
black perch	0	0	6	30	49	64	17	0	21	12	0	0	199
California scorpionfish	5	0	13	0	12	3	4	0	4	3	70	62	176
pipefish, unid.	0	0	0	30	31	30	31	31	0	0	0	0	153
plainfin midshipman	31	28	37	0	34	0	1	0	0	0	0	0	131
blacksmith	0	0	0	0	0	113	4	0	2	7	2	0	128
barred sand bass	13	0	18	0	11	9	24	0	7	31	14	0	127
kelp pipefish	1	0	4	0	2	0	1	0	7	0	33	31	79
spotted turbot	2	0	3	0	0	0	31	31	1	1	7	0	76
specklefin midshipman	0	0	0	0	0	0	34	31	5	3	0	0	73
white seabass	0	0	1	0	0	0	31	31	4	1	5	0	73
speckled sanddab	1	0	0	0	0	1	0	0	0	0	31	31	64
kelp perch	0	0	0	0	0	3	3	0	55	2	0	0	63
deep body anchovy	22	0	1	0	0	0	0	0	0	4	29	0	56
spotted kelpfish	0	0	0	0	2	10	17	0	6	3	2	0	40
black croaker	2	0	1	0	1	1	6	0	2	12	5	0	30
chub mackerel	1	0	2	0	1	0	0	0	2	5	19	0	30
rockpool blenny	2	0	1	0	10	6	1	0	1	0	0	0	21
senorita	0	0	10	0	1	0	0	0	2	0	0	0	13
California corbina	1	0	0	0	0	0	5	0	0	0	5	0	11
vermillion rockfish	0	0	0	0	1	10	0	0	0	0	0	0	11
rock wrasse	0	0	0	0	0	1	7	0	0	1	0	0	9
mussel blenny	0	0	0	0	0	0	0	0	0	0	8	0	8
spotfin croaker	7	0	1	0	0	0	0	0	0	0	0	0	8

Continued on following page

Appendix B. Estimated Monthly Number of Fish at SONGS Unit 2 in 2003 (Continued)

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
kelpbass	0	0	0	0	0	1	1	0	0	0	4	1	0	7
pile perch	0	0	0	0	0	0	2	2	0	2	0	0	0	6
basketweave cusk-eel	1	0	4	0	0	0	0	0	0	0	0	0	0	5
brown rockfish	0	0	0	0	0	1	0	2	0	0	0	0	0	3
rubberlip seaperch	0	0	0	0	0	0	1	1	0	0	0	1	0	3
shovelnose guitarfish	0	0	1	0	0	0	0	1	0	1	0	0	0	3
striped kelpfish	0	0	0	0	0	3	0	0	0	0	0	0	0	3
California halibut	1	0	0	0	0	0	0	0	0	0	0	2	0	2
dwarf perch	1	0	0	0	0	0	0	1	0	0	0	0	0	2
spotted cusk-eel	0	0	0	0	0	0	0	0	0	1	1	0	0	2
bonehead sculpin	0	0	0	0	0	0	0	0	0	0	0	1	0	1
California butterfly ray	0	0	0	0	0	0	0	1	0	0	0	0	0	1
grass rockfish	0	0	0	0	0	0	0	0	0	0	0	1	0	1
horn shark	0	0	1	0	0	0	0	0	0	0	0	0	0	1
kelp rockfish	0	0	0	0	0	1	0	0	0	0	0	0	0	1
onespot fringehead	1	0	0	0	0	0	0	0	0	0	0	0	0	1
opaleye	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Pacific barracuda	0	0	0	0	0	0	0	0	0	0	1	0	0	1
rainbow seaperch	0	0	0	0	0	0	0	1	0	0	0	0	0	1
snubnose sculpin	0	0	0	0	0	0	0	0	0	0	0	1	0	1
zebra perch	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	5867	3696	7420	22111	24550	25398	405287	403252	11457	29753	28951	27654	995398	

APPENDIX C.

**Estimated Monthly Catch in Kilograms of Fish
at SONGS Unit 2 in 2003.**

Appendix C. Estimated Monthly Catch in Kilograms at SONGS Unit 2 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
northern anchovy	5.690	3.920	12.020	231.615	243.777	263.448	1281.590	1279.906	26.640	75.254	13.811	8.061	3445.733
queenfish	24.111	15.682	43.861	10.801	32.631	23.074	345.742	323.929	21.556	48.846	102.368	97.347	1089.948
Pacific sardine	23.120	3.360	4.300	0.600	0.650	0.590	49.707	49.597	1.560	52.771	39.913	40.923	267.092
yellowfin croaker	1.350	0.000	0.620	0.000	0.000	0.220	33.550	0.000	8.000	99.060	1.280	0.000	144.080
plainfin midshipman	44.644	40.324	44.813	0.000	1.580	0.000	0.030	0.000	0.000	0.000	0.000	0.000	131.392
jacksmelt	46.610	4.200	15.610	0.600	3.190	1.670	6.790	5.890	0.184	1.372	7.991	7.751	101.858
Pacific pompano	0.140	0.000	2.860	0.000	0.180	0.000	40.968	40.607	7.694	0.400	0.150	0.000	92.999
salema	0.300	0.000	0.060	0.000	0.120	0.510	2.400	0.000	22.840	36.981	0.880	0.124	64.215
sargo	0.370	0.000	0.830	0.000	0.000	0.870	47.620	0.000	5.820	6.700	0.160	0.000	62.370
jack mackerel	4.240	2.520	3.420	0.000	0.070	0.030	8.430	8.059	0.132	2.346	8.520	3.720	41.488
topsmelt	1.070	0.000	0.030	0.000	0.000	2.480	5.420	4.030	0.066	1.916	12.980	1.550	29.542
walleye surfperch	2.340	0.000	0.750	2.100	2.320	2.136	6.030	2.480	3.570	0.893	1.560	0.620	24.798
barred sand bass	1.110	0.000	4.230	0.000	2.260	1.740	3.450	0.000	0.960	7.440	3.490	0.000	24.680
shovelnose guitarfish	0.000	0.000	6.200	0.000	0.000	0.000	4.950	0.000	4.200	0.000	0.000	0.000	15.350
shiner perch	0.720	0.000	0.180	1.200	3.390	1.450	1.310	0.000	1.080	2.350	2.140	0.000	13.821
white croaker	0.480	0.000	0.830	0.000	1.050	0.330	3.120	1.550	2.706	1.700	1.060	0.000	12.826
California grunion	2.180	1.960	2.170	0.900	0.990	0.945	0.000	0.000	0.000	0.000	0.000	0.000	9.146
spotted turbot	0.020	0.000	0.003	0.000	0.000	0.000	4.340	4.340	0.027	0.010	0.060	0.000	8.800
California scorpionfish	0.440	0.000	0.950	0.000	1.100	0.300	0.400	0.000	0.400	0.150	3.200	0.000	6.940
specklefin midshipman	0.000	0.000	0.000	0.000	0.000	0.330	2.490	0.930	1.904	0.990	0.000	0.000	6.644
blacksmith	0.000	0.000	0.000	0.000	0.020	5.230	0.140	0.000	0.100	0.300	0.002	0.000	5.792
black perch	0.000	0.000	0.690	0.300	0.590	1.155	0.630	0.000	1.100	1.070	0.000	0.000	5.535
cabezon	0.000	0.000	0.970	0.600	0.770	1.390	0.310	0.000	0.070	0.060	0.000	0.000	4.170
chub mackerel	0.100	0.000	0.300	0.000	0.160	0.000	0.000	0.000	0.290	0.820	2.260	0.000	3.930
white seaperch	0.210	0.000	0.310	0.600	0.760	0.710	0.000	0.000	0.730	0.240	0.000	0.000	3.560
giant kelpfish	0.450	0.280	0.350	0.000	0.160	0.260	0.750	0.310	0.101	0.130	0.210	0.093	3.095
bocaccio	0.000	0.000	0.000	0.600	0.620	0.610	0.680	0.000	0.140	0.000	0.000	0.000	2.650
white seabass	0.000	0.000	0.110	0.000	0.000	0.000	0.970	0.620	0.202	0.160	0.480	0.000	2.542
black croaker	0.210	0.000	0.200	0.000	0.180	0.060	0.540	0.000	0.120	0.780	0.240	0.000	2.330
horn shark	0.000	0.000	2.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.060
California corbina	0.030	0.000	0.000	0.000	0.000	0.000	1.340	0.000	0.000	0.000	0.180	0.000	1.550
rock wrasse	0.000	0.000	0.000	0.000	0.000	0.140	1.070	0.000	0.000	0.140	0.000	0.000	1.350
deep body anchovy	0.300	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.620	0.310	1.301
speckled sanddab	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.610	0.620	1.235
kelp perch	0.000	0.000	0.000	0.000	0.000	0.020	0.040	0.000	0.910	0.040	0.000	0.000	1.010
kelp rockfish	0.000	0.000	0.000	0.000	0.001	0.940	0.000	0.000	0.000	0.000	0.000	0.000	0.941
kelpbass	0.000	0.000	0.000	0.000	0.390	0.000	0.000	0.000	0.000	0.420	0.130	0.000	0.940
pipefish, unid.	0.000	0.000	0.000	0.090	0.093	0.089	0.310	0.310	0.001	0.000	0.000	0.000	0.893
grass rockfish	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.780	0.000	0.780
zebra perch	0.000	0.000	0.000	0.000	0.000	0.000	0.730	0.000	0.000	0.000	0.000	0.000	0.730
opaleye	0.000	0.000	0.000	0.000	0.000	0.720	0.000	0.000	0.000	0.000	0.000	0.000	0.720

Continued on following page

Appendix C. Estimated Monthly Catch in Kilograms at SONGS Unit 2 in 2003 (Continued)

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
onespot fringehead	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700
senorita	0.000	0.000	0.380	0.000	0.060	0.000	0.000	0.000	0.110	0.000	0.000	0.000	0.550
spotted kelpfish	0.000	0.000	0.000	0.000	0.010	0.060	0.200	0.000	0.050	0.050	0.020	0.000	0.390
rubberlip seaperch	0.000	0.000	0.000	0.000	0.000	0.010	0.030	0.000	0.000	0.000	0.230	0.000	0.270
spotfin croaker	0.200	0.000	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270
pile perch	0.000	0.000	0.000	0.000	0.000	0.050	0.040	0.000	0.140	0.000	0.000	0.000	0.230
rockpool blenny	0.010	0.000	0.005	0.000	0.060	0.060	0.020	0.000	0.010	0.000	0.000	0.000	0.165
California butterfly ray	0.000	0.000	0.000	0.000	0.000	0.000	0.130	0.000	0.000	0.000	0.000	0.000	0.130
basketweave cusk-eel	0.020	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110
kelp pipefish	0.001	0.000	0.004	0.000	0.002	0.000	0.002	0.000	0.020	0.000	0.040	0.031	0.100
California halibut	0.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.000	0.060
mussel blenny	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.040
Pacific barracuda	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.040
vermillion rockfish	0.000	0.000	0.000	0.000	0.001	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.031
spotted cusk-eel	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.020	0.000	0.000	0.030
dwarf perch	0.020	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.023
rainbow seaperch	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.020
brown rockfish	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.010
striped kelpfish	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
bonehead sculpin	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.004
snubnose sculpin	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002
	161.3	72.247	149.3	250.006	297.195	311.658	1856.301	1722.557	113.44	343.5	205.472	161.15	5644.131

APPENDIX D.

**Estimated Monthly Number of Fish Impinged
at SONGS Unit 3 in 2003.**

Appendix D. Estimated Monthly Number of Fish at SONGS Unit 3 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
northern anchovy	2571	7361	12245	36927	39695	39714	717275	719876	699117	961	4430	1344	2281516
queenfish	5122	14667	24398	4704	5008	5632	19900	21826	20051	22848	22327	25396	191879
Pacific sardine	1223	3504	5828	123	124	141	12275	12282	11900	992	1060	1145	50597
Pacific pompano	0	0	0	2	2	4	7439	7448	7253	0	9	5	22163
jacksmelt	156	447	744	674	157	144	31	32	46	992	1154	1095	5672
white seaperch	0	0	0	1142	1203	1156	31	55	33	0	2	2	3624
white croaker	20	56	93	327	350	369	93	449	191	0	7	71	2025
walleye surfperch	0	0	0	436	434	475	93	200	154	0	3	82	1877
shiner perch	0	0	0	543	586	574	0	60	23	0	21	29	1836
bocaccio	0	0	0	540	558	549	0	12	2	0	0	0	1661
sargo	0	0	0	0	0	81	0	648	128	0	5	2	864
specklefin midshipmar	20	56	93	90	93	94	124	128	122	0	3	0	822
black perch	0	0	0	182	213	203	0	6	1	0	2	0	607
jack mackerel	0	0	0	2	0	5	0	2	157	62	152	112	492
deep body anchovy	33	93	155	0	0	0	0	0	0	31	76	100	488
yellowfin croaker	0	0	0	4	0	44	0	166	141	0	61	0	416
California grunion	0	0	0	90	93	90	0	0	1	31	33	31	369
giant kelpfish	0	0	0	94	95	89	0	4	17	0	6	7	312
kelp pipefish	0	0	0	30	31	30	31	31	31	31	30	36	281
salema	0	0	0	5	1	22	0	116	48	0	7	67	266
California lizardfish	0	0	0	0	0	0	62	62	60	0	0	1	185
rockpool blenny	0	0	0	35	32	36	0	0	0	0	11	56	170
cabezon	0	0	0	33	45	73	0	5	1	0	0	1	158
topsmelt	0	0	0	0	0	2	31	33	30	0	18	5	119
white seabass	0	0	0	0	0	0	0	3	5	31	36	35	110
yellow snake eel	0	0	0	0	0	0	31	31	30	0	0	0	92
barred sand bass	0	0	0	18	4	13	0	17	14	0	19	0	85
crevice kelpfish	7	19	31	0	3	0	0	0	0	0	0	0	59
speckled sanddab	7	19	31	0	0	0	0	0	0	0	1	1	58
kelp perch	0	0	0	0	0	3	0	35	1	0	0	0	39
chub mackerel	0	0	0	0	0	0	0	0	3	0	21	0	24
California scorpionfish	0	0	0	5	2	2	0	3	3	0	4	1	20
spotted kelpfish	0	0	0	0	0	13	0	2	0	0	4	0	19
spotted turbot	0	0	0	2	2	2	0	0	1	0	5	7	19
rock wrasse	0	0	0	0	1	5	0	6	1	0	0	0	13
black croaker	0	0	0	0	0	0	0	0	0	0	6	6	12
blacksmith	0	0	0	1	0	3	0	2	3	0	3	0	12
kelpbass	0	0	0	0	0	6	0	1	2	0	0	0	9
plainfin midshipman	0	0	0	3	6	0	0	0	0	0	0	0	9
spotfin croaker	0	0	0	2	1	0	0	2	2	0	1	0	8
California corbina	0	0	0	0	0	3	0	0	1	0	0	2	6
shovelnose guitarfish	0	0	0	1	0	1	0	2	1	0	0	0	5
striped kelpfish	0	0	0	0	0	0	0	0	4	0	0	1	5
vermillion rockfish	0	0	0	0	0	4	0	0	0	0	1	0	5
basketweave cusk-eel	0	0	0	3	0	0	0	1	0	0	0	0	4
Pacific barracuda	0	0	0	0	0	0	0	0	0	0	4	0	4

Continued on following page

Appendix D. Estimated Monthly Number of Fish at SONGS Unit 3 in 2003 (Continued)

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
round stingray	0	0	0	2	1	1	0	0	0	0	0	0	4
senorita	0	0	0	1	0	1	0	1	1	0	0	0	4
brown rockfish	0	0	0	0	0	3	0	0	0	0	0	0	3
rubberlip seaperch	0	0	0	0	1	0	0	1	1	0	0	0	3
bat ray	0	0	0	1	0	0	0	0	0	0	0	0	1
California halibut	0	0	0	0	1	0	0	0	0	0	0	0	1
gray smoothhound	0	0	0	0	0	1	0	0	0	0	0	0	1
horn shark	0	0	0	1	0	0	0	0	0	0	0	0	1
mussel blenny	0	0	0	0	0	0	0	1	0	0	0	0	1
Pacific staghorn sculpi	0	0	0	0	0	0	0	0	0	0	1	0	1
pile perch	0	0	0	0	0	0	0	1	0	0	0	0	1
rainbow seaperch	0	0	0	0	0	0	0	1	0	0	0	0	1
spotfin surfperch	0	0	0	1	0	0	0	0	0	0	0	0	1
zebra perch	0	0	0	0	0	0	0	1	0	0	0	0	1
	9156	26221	43618	46024	48742	49585	757416	763552	739581	25979	29523	29640	2569039

APPENDIX E.

**Estimated Monthly Catch in Kilograms of Fish
at SONGS Unit 3 in 2003.**

Appendix E. Estimated Monthly Catch in Kilograms at SONGS Unit 3 in 2003

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
northern anchovy	8.00	22.92	38.13	442.73	487.95	486.61	2817.95	2827.23	2741.36	3.41	20.95	4.79	9902.05
queenfish	51.41	147.23	244.91	87.44	101.71	123.08	583.37	647.29	595.14	103.54	105.81	118.34	2909.27
Pacific sardine	54.47	155.98	259.48	6.14	6.20	6.86	512.07	512.37	495.98	16.12	17.08	18.84	2061.60
Pacific pompano	0.00	0.00	0.00	0.08	0.08	0.14	158.71	158.96	154.64	0.00	0.27	0.13	473.00
sargo	0.00	0.00	0.00	0.00	0.00	23.05	0.00	203.38	34.80	0.00	0.97	0.02	262.22
jacksmelt	8.72	24.97	41.54	38.32	9.76	7.49	1.86	1.91	2.51	29.45	39.70	33.52	239.76
specklefin midshipman	0.13	0.37	0.62	9.00	9.30	9.95	21.08	21.92	20.77	0.00	0.33	0.00	93.47
yellowfin croaker	0.00	0.00	0.00	0.62	0.00	9.80	0.00	34.70	33.10	0.00	11.30	0.00	89.52
white croaker	1.04	2.98	4.96	6.05	7.12	7.06	0.93	9.63	2.98	0.00	0.38	1.66	44.79
jack mackerel	0.00	0.00	0.00	0.08	0.00	0.22	0.00	0.21	10.76	0.62	9.45	3.44	24.78
white seaperch	0.00	0.00	0.00	4.51	4.86	5.36	2.79	3.62	2.86	0.00	0.05	0.02	24.06
walleye surfperch	0.00	0.00	0.00	3.75	3.10	4.14	1.86	4.44	3.60	0.00	0.07	2.31	23.27
shovelnose guitarfish	0.00	0.00	0.00	2.28	0.00	5.00	0.00	5.00	4.06	0.00	0.00	0.00	16.34
barred sand bass	0.00	0.00	0.00	2.15	1.85	2.06	0.00	3.16	1.93	0.00	4.60	0.00	15.75
salema	0.00	0.00	0.00	0.10	0.10	1.14	0.00	7.44	3.27	0.00	0.47	0.64	13.16
shiner perch	0.00	0.00	0.00	1.87	2.67	2.24	0.00	0.85	0.33	0.00	0.36	0.48	8.80
black perch	0.00	0.00	0.00	1.21	1.86	1.94	0.00	0.34	0.30	0.00	0.18	0.00	5.83
kelp pipefish	0.00	0.00	0.00	0.90	0.93	0.89	0.93	0.93	0.93	0.03	0.03	0.05	5.62
white seabass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.45	1.24	1.75	1.67	5.58
California lizardfish	0.00	0.00	0.00	0.00	0.00	0.00	1.86	1.86	1.80	0.00	0.00	0.00	5.52
bocaccio	0.00	0.00	0.00	1.50	1.55	1.63	0.00	0.37	0.08	0.00	0.00	0.00	5.13
giant kelpfish	0.00	0.00	0.00	1.33	1.42	1.18	0.00	0.19	0.56	0.00	0.19	0.09	4.96
deep body anchovy	0.39	1.12	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.71	0.37	4.76
topsmelt	0.00	0.00	0.00	0.00	0.00	0.08	1.24	1.28	1.20	0.00	0.70	0.16	4.66
yellow snake eel	0.00	0.00	0.00	0.00	0.00	0.00	1.24	1.24	1.20	0.00	0.00	0.00	3.68
chub mackerel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	2.38	0.00	2.95
California grunion	0.00	0.00	0.00	0.30	0.31	0.31	0.00	0.00	0.01	0.62	0.65	0.62	2.82
horn shark	0.00	0.00	0.00	2.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.81
spotted kelpfish	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.03	2.00	0.00	0.49	0.00	2.54
California scorpionfish	0.00	0.00	0.00	0.38	0.47	0.20	0.00	0.37	0.35	0.00	0.36	0.02	2.15
round stingray	0.00	0.00	0.00	1.15	0.46	0.39	0.00	0.00	0.00	0.00	0.00	0.00	2.00
kelpbass	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.33	0.49	0.00	0.00	0.00	1.93
cabezon	0.00	0.00	0.00	0.18	0.33	0.89	0.00	0.10	0.03	0.00	0.00	0.07	1.59
spotfin croaker	0.00	0.00	0.00	0.00	0.23	0.00	0.00	1.20	0.00	0.00	0.13	0.00	1.56
rock wrasse	0.00	0.00	0.00	0.00	0.08	0.53	0.00	0.75	0.12	0.00	0.00	0.00	1.48
rockpool blenny	0.00	0.00	0.00	0.35	0.31	0.37	0.00	0.00	0.00	0.00	0.03	0.11	1.17
gray smoothhound	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
zebra perch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.80
black croaker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.18	0.78
bat ray	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
blacksmith	0.00	0.00	0.00	0.04	0.00	0.16	0.00	0.09	0.19	0.00	0.13	0.00	0.61
speckled sanddab	0.07	0.19	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.59
kelp perch	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.45	0.01	0.00	0.00	0.00	0.50
California corbina	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.05	0.48
rubberlip seaperch	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.36	0.00	0.00	0.00	0.39
Pacific barracuda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.32
plainfin midshipman	0.00	0.00	0.00	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32

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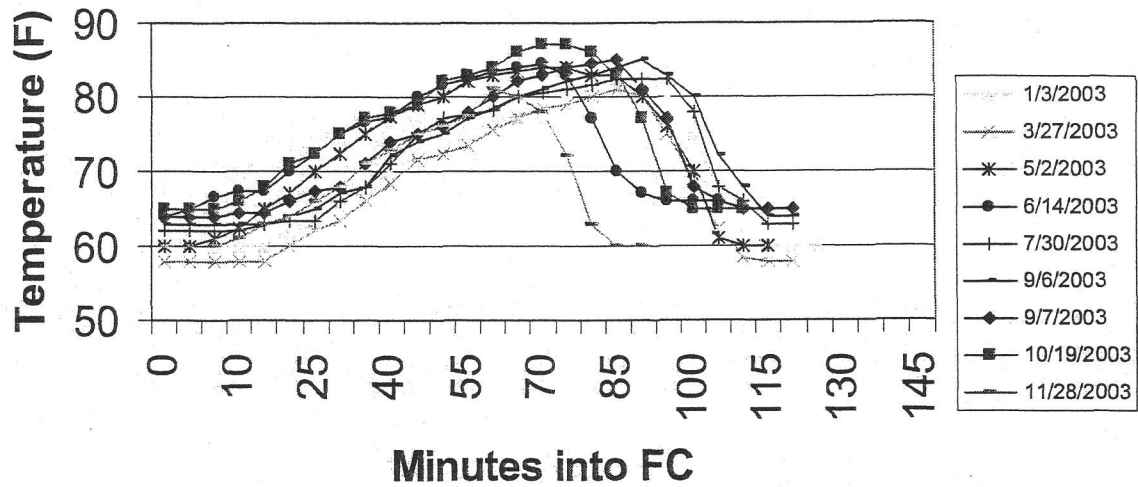
Appendix E. Estimated Monthly Catch in Kilograms at SONGS Unit 3 in 2003 (Continued)

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
spotfin surfperch	0.00	0.00	0.00	0.17	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.32
California halibut	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.31
spotted turbot	0.00	0.00	0.00	0.01	0.02	0.04	0.00	0.00	0.00	0.01	0.00	0.01	0.30
brown rockfish	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.27
senorita	0.00	0.00	0.00	0.04	0.00	0.02	0.00	0.13	0.05	0.00	0.00	0.00	0.24
basketweave cusk-eel	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.10
striped kelpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.08
crevice kelpfish	0.01	0.02	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Pacific staghorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
vermillion rockfish	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.03
pile perch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
rainbow seaperch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
mussel blenny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
	124.24	355.78	591.84	616.43	642.89	705.82	4105.89	4453.12	4119.15	155.35	220.52	187.83	16278.85

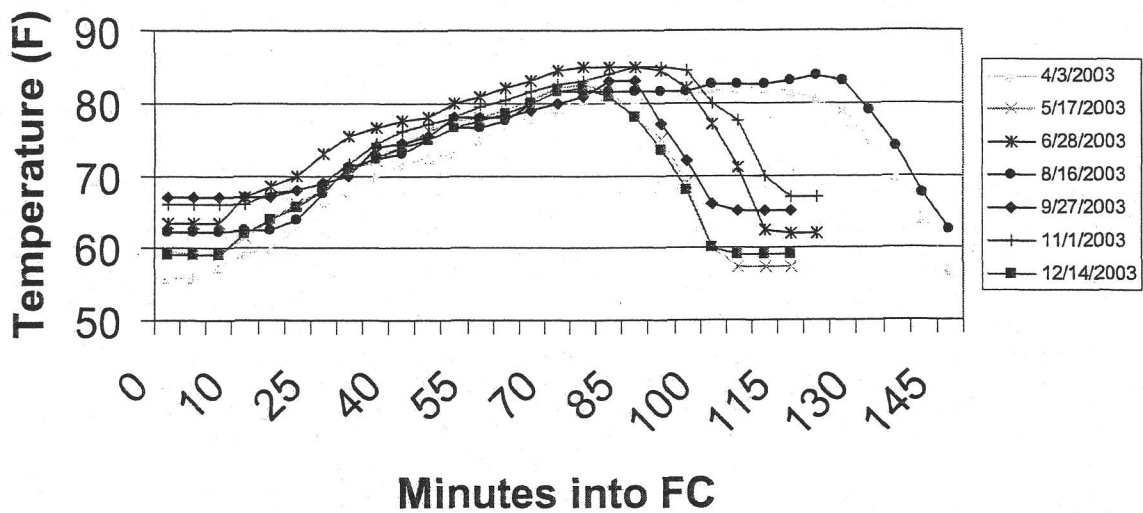
APPENDIX F.

Graphs Of Temperature Curves for Fish Chases At SONGS Units 2 and 3 in 2003

Figure F-1 Unit 2 Fish Chase Temperature



Unit 3 Fish Chase Temperature



APPENDIX G.

Summary of Fish Released During Fish Chase Operations (By Species)

Appendix G. Summary of Fish Released During Fish Chase Operations (By Species) in 2003.

Common Name	Unit 2 Fish Chase		Unit 3 Fish Chase		Unit 2 Heat treat		Unit 3 Heat treat		% Returned by Count	% Returned by Biomass
	Number	Kgs	Number	Kgs	Number	Kgs	Number	Kgs		
barcheek pipefish	1	0.04								
barred sand bass	303	62.15	213	35.28	127	24.68	85	15.75	70.88%	70.67%
barred surfperch			4	0.44					100.00%	100.00%
basketweave cusk-eel			1	0.05	5	0.11	4	0.1	10.00%	19.23%
bat ray	1	0.5	8	46.35			1	0.67	90.00%	98.59%
black croaker	43	2.86	6	0.31	30	2.33	12	0.78	53.85%	50.48%
black perch	14	1.27	20	2.46	108	4.63	64	2.21	16.50%	35.29%
blacksmith	20	0.793	4	0.18	128	5.772	12	0.61	14.63%	13.23%
bocaccio					38	0.84	32	0.6	0.00%	0.00%
bonehead sculpin					1	0.004			0.00%	0.00%
brown rockfish			1	0.25	3	0.03	3	0.27	14.29%	45.45%
cabezon	9	1.7	2	0.36	118	2.36	67	1.14	5.61%	37.05%
California butterfly ray			1	8	1	0.13			50.00%	98.40%
California corbina	38	9.88	17	1.93	11	1.55	5	0.48	77.46%	85.33%
California grunion			1	0.01	11	0.13	5	0.07	5.88%	4.76%
California halibut	1	3.6	1	8	2	0.06	2	0.31	33.33%	96.91%
California lizardfish							1	0.004	0.00%	0.00%
California scorpionfish	28	3.49	14	1.34	54	6.94	20	2.15	36.21%	34.70%
chub mackerel	62	9.26	11	1.76	30	3.93	24	2.95	57.48%	61.56%
crevice kelpfish							3	0.02	0.00%	0.00%
deep body anchovy					56	0.69	115	0.47	0.00%	0.00%
dwarf perch					2	0.023			0.00%	0.00%
giant kelpfish	15	1.14	20	0.75	44	1.39	40	1.34	29.41%	40.91%
giant seabass	1	16	14	333					100.00%	100.00%
grass rockfish					1	0.78			0.00%	0.00%
gray smoothhound							1	1	0.00%	0.00%
halfmoon	2	0.44	2	0.3					100.00%	100.00%
horn shark	1	3	3	4.7	1	2.06	1	2.81	66.67%	61.26%
jack mackerel	125	9.76			157	9.9	308	22.94	21.19%	22.91%
jacksmelt	1621	90.22	217	12.31	1160	59.46	1017	57.12	45.78%	46.79%
kelp perch					63	1.01	39	0.5	0.00%	0.00%
kelp pipefish					18	0.039	6	0.05	0.00%	0.00%
kelp rockfish					1	0.001			0.00%	0.00%
kelpbass	14	2.31	48	12.24	7	1.88	9	1.93	79.49%	79.25%
leopard shark	3	22	3	10					100.00%	100.00%
mussel blenny	0	0			8	0.04	1	0.01	99.95%	99.94%
northern anchovy	16703	80.07	44266	217.69	36377	153.5	16997	127.5	53.32%	51.45%
onespot fringehead					1	0.7			0.00%	0.00%
opaleye	3	1.8			1	0.72			75.00%	71.43%
Pacific barracuda					1	0.04	4	0.32	0.00%	0.00%
Pacific halibut					1	0.11			0.00%	0.00%
Pacific pompano	154	4.56	4	0.15	381	11.62	85	2	25.32%	25.70%
Pacific sardine	1366	28.77	54	1.43	4827	74.39	307	6.01	21.67%	27.31%

Continued on following page

Appendix G. Summary of Fish Released During Fish Chase Operations (By Species) in 2003. (Continued)

Common Name	Unit 2 Fish Chase		Unit 3 Fish Chase		Unit 2 Heat treat		Unit 3 Heat treat		% Returned by Count	% Returned by Biomass
	Number	Kgs	Number	Kgs	Number	Kgs	Number	Kgs		
Pacific staghorn sculpin							1	0.04	0.00%	0.00%
pile perch	1	0.8	5	0.56	6	0.23	1	0.02	46.15%	84.47%
plainfin midshipman	5	0.23	1	0.05	41	1.78	9	0.32	10.71%	11.76%
queenfish	2874	65.8	2264	56.66	6478	165.8	10418	245.2	23.32%	22.95%
rainbow seaperch					1	0.02	1	0.02	0.00%	0.00%
rock wrasse	2	0.35	1	0.11	9	1.35	13	1.48	12.00%	13.98%
rockpool blenny	1	0.01			21	0.165	79	0.264	0.99%	2.28%
round stingray			2	0.79			4	2	33.33%	28.32%
rubberlip seaperch	1	0.3			3	0.27	3	0.39	14.29%	31.25%
salema	963	62.48	776	45.75	943	63.97	266	13.16	58.99%	58.39%
sargo	361	70.49	1056	314.65	326	62.37	864	262.2	54.35%	54.27%
senorita			3	0.07	13	0.55	4	0.24	15.00%	8.14%
shiner perch					593	10.2	207	3.37	0.00%	0.00%
shovelnose guitarfish	10	48.21	1	8	3	15.35	5	16.34	57.89%	63.95%
snubnose sculpin					1	0.002			0.00%	0.00%
speckled sanddab			1	0.01	2	0.012	2	0.03	20.00%	19.23%
specklefin midshipman	5	3.54	10	6.8	12	4.78	14	2.64	36.59%	58.22%
spotfin croaker	27	10.71	673	430.59	8	0.27	8	3.73	97.77%	99.10%
spotfin surfperch					40	0.39	1	0.02	0.00%	0.00%
spotted cusk-eel					2	0.03			0.00%	0.00%
spotted kelpfish							19	0.67	0.00%	0.00%
spotted turbot			2	0.01	14	0.103	19	0.3	5.71%	2.42%
striped kelpfish					3	0.01	5	0.08	0.00%	0.00%
topsmelt	183	4.9	25	0.97	356	18.41	27	0.98	35.19%	23.24%
vermillion rockfish	1	0.06			11	0.031	5	0.03	5.88%	49.59%
walleye surfperch	337	12.71	74	3.28	427	12.27	334	8.7	35.07%	43.26%
white croaker	27	0.94	39	1.24	416	9.72	766	21.28	5.29%	6.57%
white seabass	3	1.25	8	2.05	11	0.95	18	1.9	27.50%	53.66%
white seaperch	21	0.73	4	0.44	100	2.1	93	2.205	11.47%	21.37%
yellow snake eel			1	0.05					100.00%	100.00%
yellowfin croaker	281	76.91	418	87.1	526	144.1	416	89.52	42.60%	41.25%
zebra perch	2	1.46	13	10.45	1	0.73	1	0.8	88.24%	88.62%
	25633	717	50312	1669	54141	888	32873	930	0.00%	0.00%

APPENDIX H.
Species of Special Interest Impinged or Entrained During 2003

Many researchers and resource managers have found impingement data to be a valuable tool in understanding the dynamics of marine organisms in near-shore coastal waters. Though not a required part of this marine environmental monitoring report, the following information is provided for those who may be interested:

Appendix H. Species of Special Interest Entrained in 2003

Species	Reason for Concern	Impinged Returned Alive				
		Unit 2	Unit 3	Unit 2	Unit 3	Total
	Fish					
California Halibut	Important sport and commercial fish	3	1	1	8	13
Cabazon	Species of Special Concern	480	158	9	2	649
Bocaccio	Species of Special Concern	762	1661	0	0	2423
Giant Sea Bass	Protected in California	0	0	1	14	15
Kelp Bass	Important recreational fish	7	9	14	48	78
White Sea Bass	Important sport and commercial fish	73	110	3	8	194
	Mammals and Turtles					
California Sea Lion	Marine Mammal Protection Act	15	13	2	9	39
Harbor Seal	Marine Mammal Protection Act	2	8	5	6	21
Green Sea Turtle	Endangered Species Act	0	0	0	0	0